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OBSERVATIONS ON THE FLIGHT PERIODICITY OF BUTTERFLIES IN WEST MALAYSIA

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ABSTRACT. Data are presented on the flight activity of a large number of butterfly species observed over an eight-day period in West Malaysia. There is also discussion on variation in the flight periodicity shown by *Melanocyma faunula* (Westwood) (Amathusiidae) across altitude.

It has often been observed by naturalists who have collected in tropical regions that many species of butterflies display a distinctive periodicity in their flight activity. However, few empirical data have been published to support these observations, and what literature is available is sparse and confined to general comments concerning broad taxonomic groupings (Corbet & Pendlebury, 1978; Emmel, 1976) or contained in detailed studies of particular species (for example, Scott, 1974).

Area and Methods

During a recent visit to West Malaysia, I collected, over a period of eight days, data on the flight activity of a large number of butterfly species. The method of data collection was to remain all day at a vantage point and note the number of sightings over half-hour intervals of various species of butterflies. I could record only those species with which I was familiar and which were unmistakable in flight; hence, I made no records of Lycaenidae or Hesperiidae.

Data were collected at two sites. The first, Tapah, where the most detailed studies were made, was along a steep mountain watercourse at an altitude of about 700 m. The vantage point was a rocky outcrop beside the stream, and it was from here that I made most of my observations. There was a wide break in the forest canopy along the stream, so the area received plenty of sunlight from about 0730 h until 1430 h. The forest was basically of a lowland type, with buttressed trees, vines, and large-leafed dipterocarps, although noticeably less luxuriant than forest at lower altitudes.

The second locality was at Tanah Rata, some 30 km from the first site, at an altitude of 1300 m. Here, too, the observation point was beside a stream, and the forest was open enough to allow sunlight to penetrate for the greater part of the day. The forest was of a stunted and open montane type, with smaller leaved trees and no vines.

In practical terms, an advantage of both sites was that neither afforded too great a field or range of vision, so that I was rarely confronted with too many butterflies to count or distracted by specimens at a distance too great for them to be identified quickly and accurately. In addition, overall population numbers at both sites were quite low, which permitted an accurate appreciation of butterfly activity at all times during the period of observation.

RESULTS

The observations are summarized in Tables 1, 2 and 3. For each species, numbers of sightings for each hourly interval from 0700 to 1800 h are expressed as a percentage of total number sighted. At Tapah data were collected on five days and are summarized in Table 1. Data were recorded for three days at Tanah Rata (1300 m). Table 2 summarizes these data for the first two days, which were both cloudy after 1100 h with only very occasional sunshine after 1200 h. Table 3 contains the data for the third day, which was sunny throughout. This division was made because it was noted that *M. faunula* were more active on days when the sky was overcast. The dates, and details of collecting times, are listed below each table.

Six species have been selected to illustrate various patterns of flight activity at Tapah, and histograms of percentage of sightings against time of sighting are given in Fig. 1. Fig. 2 illustrates the changing pattern of *M. faunula* activity with altitude and weather conditions.

DISCUSSION

Although the majority of butterflies were observed to fly between 0900 h and 1500 h, there are many which do not conform to this pattern.

Most Papilionidae, Pieridae, Danaidae and Nymphalidae are strictly diurnal, but there is a wide range of variation in duration of flight period and time of maximal activity.

Certain species remain active throughout the day but reserve particular periods for the different life functions. The Neotropical ithomiid, *Mechanitis isthmia,* visits flowers in the early morning and late afternoon, and devotes the warmer part of the day to courtship, mating, and oviposition, activities which take place in the shade (Emmel, 1976). My own observations in Malaysia indicate that many species of *Euthalia* (Nymphalidae) will fly around the sunlit forest margins in the early morning but move into the deep jungle later in the day.

The histograms for *Trogonoptera* and *Graphium* (Figs. 1a and 1b) show the type of pattern typical for most Papilionidae, Pieridae, Da-

TABLE 1. Observed flight activity of western Malaysian butterflies.

	700	800	900	1000	1100
PAPILIONIDAE					
Trogonoptera brookiana ♂		2.0	6.0	18.0	22.0
T. brookiana ♀		11.1	5.6	11.1	16.7
T. amphrysus		11.1	14.8	14.8	14.8
Atrophenura varuna		20.0	6.7		
A. sycorax		50.0			
Papilio helenus			2.9	20.0	22.9
P. iswara			14.3	42.9	28.6
P. nephelus				20.0	20.0
Graphium evemon		5.9	9.8	13.7	17.6
G. antiphates		3.1	6.3	9.4	31.3
G. macareus				12.5	37.5
PIERIDAE					
Leptosa nina			5.3	21.1	26.3
Cepora nadina			5.0	15.0	25.0
Appias lyncida		3.9	11.7	18.8	20.3
A. indra		6.7	26.7	20.0	33.3
A. nero			20.0	20.0	40.0
Pareronia valeria			21.4	21.4	28.6
**Eurema* spp.		3.6	13.1	14.1	15.4
Gandaca harina		17.2	20.7	20.7	20.7
DANAIDAE					
Danaus aspasia			3.3	8.8	24.2
Ideopsis gaura				20.0	20.0
Euploea mulciber		1.3	9.0	21.8	25.6
E. camaralzeman				14.3	28.6
E. diocletianus			11.1	16.7	30.6
SATYRIDAE					
**Ypthima fasciata*		0.9	6.3	9.0	23.4
**Y. pandocus*		0.6	3.5	13.3	15.6
Ragadia crisilda				25.0	25.0
Melanitis leda					
AMATHUSIIDAE					
Amathusia spp.	14.3	14.3			
Faunis gracilis	24.4	20.0	4.4		
Melanocyma faunula	3.1	3.1	3.1	3.1	3.1
Xanthotaenia busiris	8.3	8.3	16.7		
Thauria aliris	16.6	16.6	16.6		
NYMPHALIDAE					
Cupha erymanthis		2.9	5.9	14.7	20.6
Terinos terpander		5.3	10.5	20.3	15.8
Cyrestis nivea			11.1	5.6	13.9
Parthenos sylvia					30.0
Stibochiona nicea					
Polyura spp.					10.5
Charaxes bernardus					

* Figures indicate captures rather than sightings. Dates and times of observations: 5-I-79 700–1800 h, 7-I-79 600–1900 h, 9-I-79 700–1900 h, 10-I-79 600–1800 h, 13-I-79 700–1800 h.

TABLE 1. Continued.

1200	1300	1400	1500	1600	1700	1800	Total
22.0	14.0	8.0	2.0	2.0	4.0		50
16.7	16.7	11.1	5.6	5.6			18
22.2	3.7	3.7	7.4	3.7	3.7		27
	6.7	33.3	33.3				15
					50.0		2
20.0	22.9	11.4	2.9				35
14.3							7
20.0	40.0						5
35.3	11.8	3.9	2.0				51
29.7	18.8	1.6					64
25.0	25.0						8
15.8	10.5	15.8	5.3				19
25.0	25.0	5.0					20
18.8	15.6	8.6	2.3				128
13.3							15
10.0	10.0						10
21.4	7.1						14
16.0	12.7	11.1	9.8	3.6	0.7		306
10.3	8.6	1.7					58
20.9	23.1	13.2	5.5		1.1		91
20.0	40.0						5
18.0	10.3	5.1	3.8	3.8	1.3		78
14.3	14.3		28.6				7
25.0	8.3	8.3					36
17.1	16.2	14.0	10.4	2.7			222
12.7	11.0	13.9	19.1	9.8	0.6		173
12.5	12.5	12.5	12.5				8
			16.7	33.3	50.0		6
				14.3	57.1		7
			8.9	26.7	15.6		45
	6.3	6.3	34.4	28.1	9.4		32
			16.7	33.3	16.7		12
					66.7		6
29.4	11.8	8.8	5.9				34
21.1	17.5	8.8	5.3	3.5			57
27.8	22.2	16.7	2.8				36
30.0	30.0	10.0					10
		75.0	25.0				4
47.4	26.3	15.8					19
46.7	26.7	20.0	6.6				15

TABLE 2. Observed flight activity of select species.

	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	Total
Papilio helenus		12.5	50.0		25.0		12.5					8
Delias descombesi		25.0	45.0	20.0		10.0						20
Melanocyma faunula	2.8	7.5	12.3	17.9	17.0	15.1	13.2	8.5	2.8	2.8		106

Dates and time of observations: 8-I-79 800–1800 h, 11-I-79 800–1800 h.

naidae, and many Nymphalidae and Satyridae. The flight period may be more concentrated as in *Graphium*, or spaced out as in *Trogonoptera*, but in both cases more activity occurs between 1000 h and 1400 h. Unlike the other papilionids, *Atropheneura* display a less regular flight pattern (possibly a function of the small sample size), but distinctly avoid the hotter parts of the day (Fig. 1c).

The Charaxinae (Fig. 1d) have a brief period of activity in the early afternoon, with over 90% of observations being made between 1200 and 1500 h. By contrast, *Gandaca harina* (Horsefield) (Fig. 1e) prefers the early part of the day but is on the wing for a longer period. Perhaps this can be explained by the very powerful flight of the Charaxinae, which when active, pause only briefly to refresh themselves, usually at dung or carrion. *Gandaca harina* flutters weakly, always around the same tree, and settles frequently.

Faunis gracilis (Butler) (Fig. 1f) exhibits a crepuscular flight pattern typical of the Amathusiidae. Records were not kept after 1800 h, owing to poor light, but a number were seen at this time. The related *Discophora timora* (Westwood) has been recorded at fruit bait as late as 2130 h (Corbet & Pendlebury, 1978). In *M. faunula*, the crepuscular habit is less pronounced, but the bulk of flight activity at 700 m is concentrated towards evening (Fig. 2a). At 1300 m it flies throughout the day, though it is more active in the afternoon on sunny days (Fig. 2c). On cloudy days at 1300 m, there was some reduction in activity (Fig. 2b) but not to the same extent as observed in *Delias*

TABLE 3. Observed flight activity of select species.

	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	Total
Papilio helenus		12.5	6.3	18.8	18.8	12.5	18.8	12.5				16
Delias descombesi	3.4	3.4	10.3	13.8	20.7	24.1	17.2	6.9				29
Melanocyma faunula	2.9	2.9	8.7	13.0	11.6	15.9	13.0	17.4	10.1	4.3		69

Date and time of observation: 15-I-79 800–1800 h.

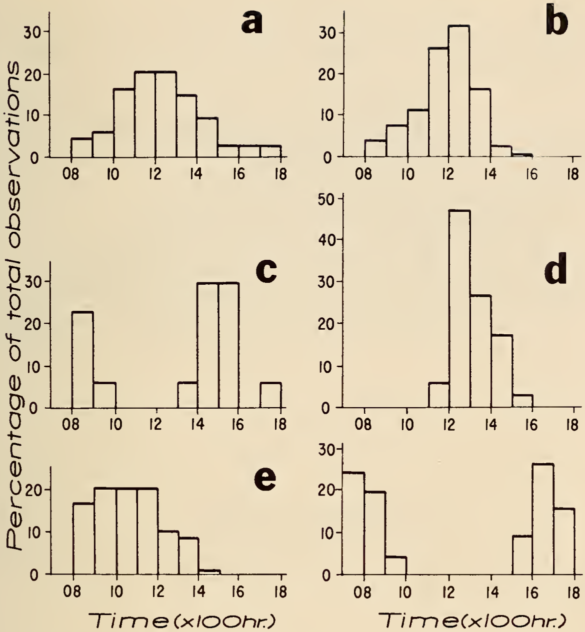

FIG. 1. Histograms illustrating flight activity of various butterfly species. **(a)** *Trogonoptera brookiana*; **(b)** *Graphium* spp.; **(c)** *Atrophaneura* spp.; **(d)** *Polyura* and *Charaxes* spp.; **(e)** *Gandaca harina*; **(f)** *Faunis gracilis*. (Histograms represent pooled results for both sexes.)

descombesi (Boisduval), a montane species not found at Tapah, which only took to wing during short periods of sunshine.

Papilio helenus (Linnaeus) displays basically similar flight patterns at 700 and 1300 m. The different flight patterns of *Melanocyma* at different altitudes suggest that temperature may be an important factor in determining activity.

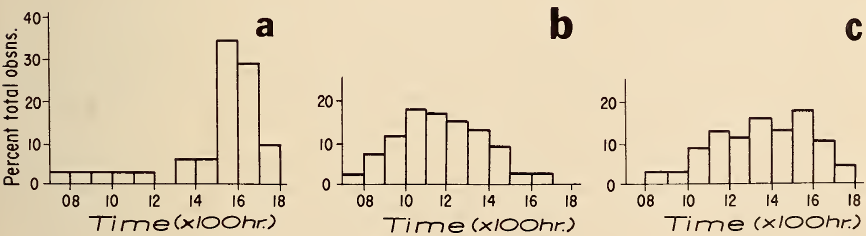

FIG. 2. Histograms illustrating flight activity of *Melanocyma faunula* under differing conditions. **(a)** 700 m, sunny day; **(b)** 1300 m, cloudy day; **(c)** 1300 m, sunny day. (Histograms represent pooled results for both sexes.)

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GENERAL NOTE

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DOWNY WOODPECKERS AS PREDATORS OF *HYALOPHORA CECROPIA* PUPAE

The leaf-drop of a large silver maple (*Acer saccharinum* L.) in my yard during the fall of 1979 revealed 12 cocoons of *Hyalophora cecropia* (Hübner) scattered among its branches, many twenty to thirty feet above the ground. These pupae developed from eggs laid by the captivity-mated females I released the preceding spring. I felt content in thinking there would be a good source of wild males should I need them for backcrosses in my hybridization studies in this moth genus. Consequently, I decided not to collect them for storage as I usually do.

On 20 December 1979, as I returned from a late afternoon walk on an unusually clear cold day, I heard a pecking noise in the tree as I passed beneath it. To my chagrin, on a high branch a female downy woodpecker (*Dendrocopos pubescens* L.) was pecking one of the cocoons. It was perched on the cocoon, pecking with some difficulty as the flexible branch moved with the force of its bill. I repeatedly tried to drive it away but it always quickly returned and continued to peck. This experience recalled my discussion with Drs. Dale F. Schweitzer and Charles L. Remington at Yale University earlier in the season of jays feeding on the pupa in cocoons and the studies of Waldbauer, Sternburg et al. (1967, Ann. Entomol. Soc. Amer., 60: 97–101; 1967, Ecology, 48: 312–315; 1970, Ann. Entomol. Soc. Amer., 63: 1366–1369) in Illinois of woodpecker predation on *Hyalophora cecropia* cocoons.

I then gathered all the cocoons I could reach with a twelve-foot extension pruner. Most had holes in them, as shown in Fig. 1. I opened several to find in most a shriveled pupal shell, its contents cleverly removed, likely by the tongue of the woodpecker. Of the seven cocoons I was able to reach, only one appeared to contain a living pupa.

I was further surprised to observe that the woodpecker seems to know which cocoons contained viable pupae, since those containing parasitized pupae appeared to be purposely avoided. Two cocoons contained dead larvae with tell-tale shriveled egg shells of tachinid parasites on their surfaces.

FIG. 1. Cocoon of *Hyalophora cecropia* with evidence of predation.

Perhaps, the woodpecker is able to hear or feel the rattle of a dry, shriveled pupae in the cocoon as it pecks, and hence avoids the wasted energy of drilling a hole through a tough pupal case only to find no food within.

It was extremely interesting to observe the behavior of this woodpecker as it methodically destroyed the remaining viable cocoons beyond my reach in the tree. There is no doubt woodpeckers find pupal Saturniidae a highly attractive food source during the winter.

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